MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

PTH0016 MODERN PHYSICS AND THERMODYNAMICS

(Foundation in Engineering)

11 MARCH 2020
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages, including the cover page.
2. Answer all questions.
3. Write your answers in the Answer Booklet provided.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) Name two types of mechanical waves and their definition. Give an example for each.

[3 marks]

b) At $t = 0$ and $x = 0$, a progressive wave with a velocity of 340 m/s, amplitude of 0.20 m and time taken for one complete cycle is 2.22×10^{-3} s is propagating to the right.

(i) Calculate the wavelength of the wave

[2 marks]

(ii) Write a wave equation of the wave

[5 marks]

QUESTION 2 (10 MARKS)

a) State two characteristics of sound waves.

[2 marks]

b) A trumpeter plays her trumpet while in a car. The note she plays has a frequency of 300 Hz but you hear a note with a frequency of 280 Hz,

i) what is the evidence that sound is a form of energy?

[2 marks]

ii) is she moving towards or away from you?

[1 mark]

iii) how fast is she moving? (Speed of sound in air is 330 m/s).

[2 marks]

c) A 50 dB sound wave strikes an eardrum whose area is $5.0 \times 10^{-5} m^2$. How much energy is received by the eardrum per second?

[3 marks]

QUESTION 3 (10 MARKS)

a) An object 2 m in height is located 3 m in front of a plane mirror.

(i) Where is the position of the image formed?

[0.5 mark]

(ii) What are the characteristics of the image formed?

[1.5 marks]

b) A 15 cm tall object is placed in front of a converging thin lens with a focal length of 20 cm. An erect, virtual and 60 cm tall image is formed by the lens. Determine the object position.

[3 marks]

Continued...

c) Red light of wavelength 650 nm is incident normally on a grating and the second order bright band is diffracted at an angular deviation of 3.80° from the central bright band.

(i) How many lines per meter are marked on the grating? State the number in integer.

[3 marks]

(ii) If the distance between the grating and screen is 2 m, calculate the distance of the the third order bright band from the central bright band.

[2 marks]

QUESTION 4 (10 MARKS)

a) Tritium and helium-3 have the same number of nucleons, but tritium has one proton and two neutrons whereas helium-3 has two protons and one neutron. Without doing a calculation, which nucleus has a greater binding energy? Explain.

[2 marks]

b) The half-life of the radioactive nucleus $^{226}_{88}Ra$ is 1.6×10^3 year. If a sample initially contains 3.00×10^{16} such nuclei, determine

(i) the initial activity in curies,

[3.5 marks]

(ii) the number of radium nuclei remaining after 4.8×10^3 year,

[2.5 marks]

(iii) the activity at this later time in curies.

[2 marks]

QUESTION 5 (10 MARKS)

a) 0.45 kg of a metal at $100°C$ is added to 0.40 kg of water at $18°C$ in an isolated system. If the final temperature of the mixture is $25°C$,

(i) which of the material absorbed energy? Explain.

[1.5 marks]

(ii) what is the specific heat capacity of the metal?

[2 marks]

(iii) what is the heat capacity of the metal?

[1.5 marks]

Given the specific heat capacity of water is 4186 $Jkg^{-1}K^{-1}$. Neglect any exchange of heat between the system with surroundings.

b) In an isobaric process, an unknown gas expands from an initial volume of 4 L to a final volume of 18 L at a pressure of 10 kPa.

(i) What is the definition of isobaric process?

[1 mark]

(ii) How much work is done by the gas?

[2 marks]

(ii) What is the change in internal energy of the gas if 10 J of heat flowed out during the process?

[2 marks]

Continued...

APPENDIXES

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 Nm^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

$$\frac{dy}{dx} = knx^{n-1}$$

Trigonometric Identity

$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

NEWTONIAN MECHANICS

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v = u + at \qquad s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as \qquad s = \left(\frac{u+v}{2}\right)t$$

$$W = Fs\cos\theta \qquad W = mg \qquad \sum F = F_{net} = ma$$

$$f = \mu N \qquad p = mv \qquad \sum F = \frac{\Delta p}{\Delta t}$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2 \qquad m_1u_1 + m_2u_2 = (m_1 + m_2)v \qquad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$$

$$K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx \qquad PE_G = mgy$$

$$v_{circular} = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r} \qquad F_g = G\frac{m_1m_2}{r^2} \qquad U_g = -G\frac{m_1m_2}{r}$$

$$T^2 = K_sr^3 \qquad T_s = 2\pi\sqrt{\frac{m}{k}} \qquad F_c = m\frac{v^2}{r}$$

$$\omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{g}{l}} \qquad T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f}$$

End of Paper.